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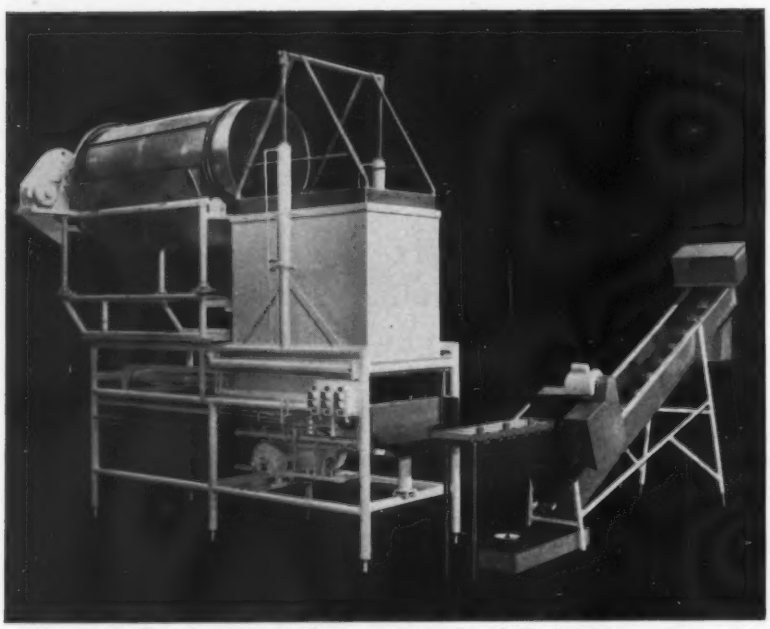

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THE AGREEMENT OF THE NATIONAL CONFERENCE ON INTERSTATE MILK SHIPMENTS; NECESSARY AREAS OF CLARIFICATION AND PROCEDURES FOR IT'S REVIEW[1]

K. G. WECKEL

Department of Dairy and Food Industries
University of Wisconsin, Madison

The Conference Agreement is a document conceived to enable the convenient interstate flow of milk. It has had almost a decade of use. It is being used, according to survey, by some 30 states, and the volume of milk transhipped by its facilities is presently estimated to be some three-fourths of a billion pounds annually, involving some 20,000 separate shipments (*1*). The object of the conference is to review the Agreement for the purpose of considering how it best can meet the objectives of enabling interstate shipment of milk. There are many who use the agreement to great advantage: in procuring supplies to meet deficit requirements; to decrease costs of import procurement, and in simplifying the mechanics of interchange.

Certain aspects of consideration of the Agreement should be known by all who participate in deliberations about its application. Perhaps the first of these is that anyone who proposes review or change of the document should first read and understand it, and secondly, to recognize that what it contains and embodies did not come lightly, but with a great deal of prior deliberation and reasoning. The second perhaps is that the document is not, and should not be considered a substitute or replacement for the legal instruments presently in use in the respective states. It is, and always was intended to be, a tool or procedure whereby the interstate shipment of milk could be enabled when such was considered desirable for any reason whatever. It is not a regulation. The various states have their own regulation. It is a voluntary Agreement to supplement and implement the transflow of milk.

It is obvious that the Agreement, as a tool, could not possibly conform to the letter, nor the interpretation of all the existing legal documents of the several states. Nor was it ever so intended. It was devised to facilitate desired inter shipment because the legal documents of the several states did and do differ. If the legal documents of the several states did not differ, there would be no need for the Agreement. There certainly is need for the Agreement, because it is being used very extensively by both regulatory and industry people. It was conceived to express what receiving states wanted, and what shipping states could provide, in qualification of a transshipped milk supply. Without question, the existence of the Agreement has had a strong beneficial influence on soul searching and self analysis of industry, community and state standards everywhere. Use of the program *has* resulted in better quality of milk; those who had milk to sell have had to improve it; those who want to buy have wanted it still better. The Agreement is not, and never was intended to abrogate states rights. It is based on faith, and understanding, and confidence. It is a document of voluntary concept.

Thus, participants to consideration of the Agreement, should first know the Agreement, and how it came into being. There is no object in proposing changes, modifications, stipulation of details and like considerations unless, in all true faith, there is intent to use the Agreement. There is no profit in rehashing, either in intent, or in ignorance, problems which have been previously carefully deliberated, unless new information can be provided. The object of consideration of the Agreement is how to best implement its use. If the Agreement is basically sound, and suits a majority on the voluntary basis, there needs to be a bending of understanding by those who may have inherent problems of application.

Any arrangement should be fair and should represent what is feasible on the part of receiving as well as shipping states. It should represent what both can live with. There can be no advantage in incorporation of specific mandatory conditions of specifications which are not, and would not be generally recognized or accepted.

It should be remembered that virtually every state is engaged in interstate shipping and receiving of raw and processed milk. Within the short history of the Agreement, some states which formerly considered themselves solely as receiving states are now strong surplus and shipping states.

In the consideration of the task force work which is to be carried out during the subsequent period of this Conference, it is pertinent to examine certain specific problems and recommendations. In the deliberations during the task force work, it is very im-

[1]Presented at the Seventh National Conference on Interstate Milk Shipments, St. Louis, Missouri, April 20, 1959.

portant that facts be separated from opinion; one of the greatest problems in the deliberations is to establish the facts, and frequently what is considered fact solely from long time application, or assumption, cannot stand the sharp scrutiny of the inquisitive mind. In order that facts can be brought to bear into the forthcoming decisions, a sincere effort was made to survey by questionnaire the problems that warranted consideration in the use of the Agreement. These have been transmitted to panel or task force chairmen so that, in so far as possible, technical or related information could be established for benefit of discussion.

There is a great need for clarification of the procedure of handling task force and committee reports in so far as they relate to the Agreement. In the past much superfluous and irrelevant wordage has crept into the Agreement as the result of having been submitted as task force recommendation. It must be admitted that in spite of the legal language experience of regulatory people, many of the reports or recommendations of the task forces have been without the precision, sharpness and clarity for proper consideration by the Conference at large, or for the Agreement. Frequently the reports of the task force have been created without reference, or regard to the other parts of the Agreement. Every task force should take every advantage of counsel and appraisal in hammering and forging its written considerations; this is fundamental to the soundness of any written document.

The Conference could well consider the use of a document committee to forestall errors of comprehension and expression. The Conference definitely is in need of clarification of what is to be channeled to the Agreement and what is simply a deliberation of a problem, and supplementary information, and prologue for further investigation.

There is a lot of superfluous material in the reports that does not bear directly on the Agreement and in fact, confuses and clouds the issues of the Agreements. The task force reports should be directed primarily to implementing the use of the Agreement. What is superfluous and wordy and what is essential purely to the Agreement? The Agreement needs simplification, and this feature should be retained for the benefit of potential users.

The Agreement has been modified in one way or another at each of the preceding conferences in the effort to implement its use. The Agreement is becoming lengthy, its intent may be at times ambiguous or obscure because of material added, and often because of the manner and place of its structure. Each task force could do no better than to consider ways and means of simplification and codification of the Agreement to eliminate co-mingling of the components, and to establish a glossary of terms, or plan in the use of terms. It is strongly recommended that each task force review the previous conference agreements, and the revisions as incorporated at the last conference (1957) for the purpose of simplification.

There exists in the present Agreement a considerable body of information which is actually not agreement, but is regulatory procedure.

The Agreement provides for use of Standard Methods for the Examination of Dairy Products for methodology by reference. To this there has been incorporated many specifications of procedure which have to do with methods of sampling and frequency, pick up of sample, bulk handling, labelling, sealing of tanks and like procedures. The latter are definitely methodology, and should be extirpated from the Agreement per se and separately established by reference. The methodology is under constant change. The magnitude of this problem is increasing in the light of the many developments in the handling of milk. The Agreement should not be transposed into a Standard Methods for the examination of dairy products, but rather such necessary addenda should be codified by reference.

There is a great deal of interstate shipment of processed dairy products. There appears to be no specific problem with respect to the evaluation of these products per se for shipment, but there is a world of confusion in the area of permissive and required labelling of such products. There are innumerable instances of conflict in the identification of given products which is not in the interests of the consumer. It is hoped the task force on labelling can unravel the problem of procedure wherein a product which conforms to quality standards of the Agreement is not acceptable in interstate trade because of want of a name.

The Conference has from time to time had Committee consideration of special category products such as concentrated milk, nonfat dry milk solids, and supplemental milk fats. There is continuing need for Committee consideration of such products for the purpose of keeping abreast of developments in a fast changing industry and to assist the Conference in appraisal of related problems. As an example; increasingly large quantities of nonfat dry milk are being used in the processing of market milk dairy products such as half and half, cottage cheese, and low fat milk. The Committee on Nonfat Dry Milk of the Conference assisted in the development of Grade A standards for this product. This standard is now available (2). The availability of this standard should result in the development of Grade A programs for nonfat milk solids and for its use in processed dairy products. The standards for nonfat dry milk were under development by the Conference Committee

over a period of four years, and then subsequently under consideration by Public Health Service since 1954. A recent study in Wisconsin indicated that over 50 per cent of the market milk plants use nonfat dry milk in process operations, and that some 10,000 pounds dry milk is used daily in Grade A operations (*3*). The use of the dry milk standards should be implemented as much as possible. There is need for further study of certain engineering aspects of water utilization in concentrating operations that will warrant further Committee consideration.

SUMMARY

In principal then, the reports of Committees should bring all facts to bear on the problem: (*a*) the work of the task force committees should clarify and improve the agreement for the purpose of implementing its use; the agreement is not a regulation, it is a voluntary program; (*b*) the work of the task forces should be a hammering and forging of clear, concise facts and recommendations for consideration of the Conference; (*c*) the proposals should be submitted with full cognizance of their role and place in the balance of the Agreement.

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FACTORS TO CONSIDER CONCERNING THE OCCURRENCE OF COLIFORMS IN CITRUS PRODUCTS[1]

ROGER PATRICK AND F. W. WENZEL

Florida Citrus Experiment Station, Lake Alfred

Since the introduction of frozen concentrated orange juice to consumers, approximately 12 years ago, the question of the sanitary significance of coliform bacteria in this product has been raised from time to time. Also, with the greater distribution of refrigerated citrus products, such as chilled orange juice, by dairies and retail stores, questions are again being asked about the occurrence of coliforms in these products. When one considers the emphasis that has been placed for a long time on the sanitary significance of coliform bacteria in water, dairy and other food products, it is not difficult to understand why inquiries are made when these organisms are found in citrus products.

This paper discusses briefly, on the basis of available data and other information, factors that should be considered by all persons who are concerned about the presence of coliforms in citrus products, so that they may interpret better results obtained from the microbiological examination of these products. Another purpose is to assemble and include all of the references in the literature covering the many investigations about the occurrence, methods of detection, differentiation, sources, survival and significance of coliform bacteria in citrus juices and concentrates. These studies have been made by the citrus industry, the frozen food industry, governmental control and research agencies, container manufacturers and various universities. A careful and thorough study of the results of these investigations indicates that the occurrence of coliform bacteria in frozen citrus concentrates and other processed citrus products is of no sanitary significance and that the health of the public has not been endangered in the past and is not liable to be in the future from the consumption of these products.

DETECTION OF COLIFORMS

The coliform group of organisms as defined in *Standard Methods for the Examination of Water and Sewage* (*3*) includes "all aerobic and facultative anaerobic, Gram-negative nonsporeforming bacilli which ferment lactose with gas formation." Since coliform bacteria ferment lactose, various media containing this sugar have been used for their detection and separation from other microorganisms in water, dairy and other food products. The inoculation of a medium with orange juice results in the addition of sucrose, dextrose, levulose and other sugars, which are

[1]Cooperative publication by the Florida Citrus Experiment Station and Florida Citrus Commission. Fla. Agr. Exp. Station Journal Series, No. 884.

natural constituents of the juice. If microorganisms other than coliforms, such as yeasts, in the citrus juice can ferment these added sugars, gas will be produced and false positive presumptive tests will result. Such false tests can be prevented to some extent, but not entirely, either by adding to media substances that inhibit the growth of organisms responsbile for the false tests or by increasing the temperature of incubation, which favors the growth of coliform bacteria but h i n d e r s that of yeasts and other organisms. Various investigators (*8, 12, 24, 27, 44, 45*) have used and compared different media including lactose, lauryl tryptose and brilliant-green lactose bile broths incubated at 27°C.; also, Vaughn-Levine boric acid broth at 43°C. and modified Eijkman medium at 46°C. When these media are inoculated with citrus juices, some false positive presumptive tests may still result even though inhibitors and increased temperatures of incubation are used. Therefore, confirmed and completed tests for coliform bacteria must be made, according to standard methods (*3*), if the presence of such bacteria is to be definitely established. Also, any attempt to estimate in orange juice coliform group density or compute the most probable number, as in the examination of water (*3*), may give erroneous and misleading results. This was again pointed out recently by Wolford (*45*), who stated that if orange juice is tested for its coliform index, all positives should be confirmed by microscopic examination. Martinez and Appleman (*24*) reported the futility of using eosin methylene blue plates for a confirmed test, since orange juice sometimes contained lactose fermenting yeasts that can give colonies on this medium identical in appearance to *Escherichia coli*. Violet red bile agar may be used for the detection of coliforms in citrus products, but the isolates must be confirmed by microscopic examination or differential tests.

DIFFERENTIATION OF COLIFORMS

Biochemical reactions of coliform bacteria found in water, dairy and other food products are used for determining their sanitary significance. The coliform group, according to the American Public Health Association (*3*), may be classified into the *Escherichia coli, Aerobacter aerogenes* and *Escherichia freundii* (or intermediate) types on the basis of the IMVIC reactions. The *E. coli* types are considered to be of fecal source and of sanitary significance, whereas the other types are considered to be of non-fecal origin.

Results from investigations reported in the literature (*28, 31, 34, 43, 46, 47, 48, 49*) on the differentiation of coliforms isolated from orange juices and concentrates show that most of these organisms have IMVIC reactions which classify them as *Aerobacter* or intermediate types. Those having IMVIC patterns, + + − −, or − + − −, corresponding to *E. coli* types, are in the minority. For example, Wolford (*43*) reported that from 1185 initial inoculations into lactose broth, a total of 236 coliform cultures were isolated from 79 samples of frozen orange juice. Forty-six of these cultures resembled *E. coli*, 20 resembled the intermediates and 170 resembled *Aerobacter* types. Similar results have been reported by other investigators (*27, 38*).

Patrick (*31*) determined the IMVIC and many other biochemical reactions of 217 coli-like cultures isolated from orange concentrates and damaged oranges. Among these reactions were nitrate reduction and gelatin liquifaction; cellobiose, salicin, sucrose, starch and inositol fermentations; also utilization of urea and uric acid. Only 2 of the 217 coliform cultures studied were confirmed in all tests to be *E. coli*. Thus, if variations in biochemical reactions are taken into consideration, the generic classification of coliforms isolated from citrus products becomes difficult. Coliform bacteria found in orange juices have also been reported (*22, 24, 34, 43*) to have some of the characteristics of the genus *Erwinia*. Kauffmann (*21*) indicated that there are cultures not true to the genus *Escherichia* or to the genus *Klebsiella*, but occupy a position between these two genera. This seems to be the position of many coliform types found in citrus juices, if their biochemical characteristics are taken into consideration.

SOURCES OF COLIFORMS

Many investigations (*15, 19, 26, 27, 28, 29, 30, 34, 36, 46, 47, 48, 49*) have been concerned with sources of the coliform bacteria found in citrus products. The effect of the condition of fruit has been checked by examination of immature, overmature, soft and damaged fruit, as well as that in good condition. Oranges collected from many places have been examined, including those picked in the grove or obtained from field boxes, trucks, fruit bins and packing houses. Both the exterior and the juice were checked for the occurrence of coliforms. Results of these investigations showed that coliform bacteria can be isolated from the exterior surfaces or juice of oranges collected from the different places; even fruit picked aseptically into sterile containers sometimes yielded coliforms. However, there was no appalling evidence that the coliform bacteria found should cause alarm. The incidence of *E. coli* types from such fruit was low. Rakieten *et al* (*32*) examined juices that were freshly extracted from oranges in different homes, as well as samples of reconstituted frozen orange concentrates, and reported the occurrence of coliform bacteria in the freshly extracted orange juices, but

none were found in the reconstituted frozen concentrates.

Wolford and Berry (*47*) and Wolford (*48, 49*) reported that the physical condition of the oranges used had a decided influence on the plate counts and the numbers of coliform bacteria found in frozen citrus juice. Juice prepared experimentally from "soft rot" Valencia oranges (*47*) contained 2,500 times as many microorganisms as juice from sound fruit. The incidence of coliform bacteria was higher also. Patrick (*30*) isolated coliforms from soft and ruptured fruit; he also reported that coliform bacteria were found on fruit infested with scale and that fruit flies could carry coliform contamination. Therefore, fruit exteriors may be a source of coliforms found in juices. However, the methods used today to prepare fruit for extraction are not favorable for such contamination.

The scale infestation and dirt clinging to the peel is removed by a thorough soaking and scrubbing, followed by clear water and chlorine-water rinses. Contamination on the peel due to human contacts, trucks, storage bins and grove-lands is removed also. The thermal stabilization processes used today for the inactivation of enzymes prior to or during concentration of citrus juices, as dicsussed by Wenzel and Moore (*42*), also are destructive to many coliform types that may be in these juices.

Good sanitary practices are used today in commercial concentrate plants, as has been indicated by Brokaw (*10*), *Dack* (*11*), *and others* (*7, 39, 40*). *However*, coliform bacteria sometimes are present in citrus concentrates even with all of these good sanitary and clean-up procedures. Therefore, it is not surprising that various investigators (*26, 28, 29, 36*) have reported, before the use of today's sanitary practices, that equipment in processing plants was a source of coliforms then found in citrus juices.

Significance of Coliforms in Citrus Products

The significance of coliform bacteria in water, milk and other food products, including frozen foods, has been discussed extensively (*3, 4, 9, 16, 20*). Hunter (*20*), Levine (*23*) and others (*1, 2, 5, 14, 41*) have discussed the uses and limitations of the coliform group in sanitary control of food production. They disapprove the use of coliform organisms as indicies of pollution when found on foods without correlative data to establish the route of contamination on that class of food.

Coliform bacteria found in citrus juices and concentrates are far less numerous than that occurring in other food products, such as ice cream, shellfish or nutmeats. Also, since citrus products are acid foods, coliforms die off rapidly when inoculated or introduced into these products at room temperature; however, it has been shown (*6, 13, 17, 18, 25, 34, 35*) that they survive for longer periods of time as the temperature is decreased and have been known to remain viable for 12 months in orange concentrate stored at 0°F.

Finally, the significant fact should be mentioned that consumers are today using approximately 65 million gallons of frozen orange concentrate yearly, as well as very large quantities of other citrus products, without any apparent ill effect upon their health. Thatcher (*37*) did not recommend the setting up and using microbial standards as criteria of healthfulness of frozen citrus juices.

Considering these factors, along with the other information discussed briefly in this paper, we must conclude that the occurrence of coliform bacteria in citrus products is of no sanitary significance, an opinion that has also been reached by other persons who have investigated the available information concerning this question.

Summary

The consideration of available information from many investigations relative to the occurrence of coliform bacteria in frozen citrus concentrates and other processed citrus products indicates that such organisms are of no sanitary significance. Methods of detection and differentiation, sources, survival and significance of coliforms in citrus products are discussed briefly. Also pointed out is the significant fact that millions of gallons of citrus juices are being consumed annually without any apparent ill effect on the health of consumers.

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A REPORT ON SANITARIANS COMPLETING GRADUATE STUDY AT A SCHOOL OF PUBLIC HEALTH, 1946-1956[1]

JOHN G. TODD[2] AND EMIL T. CHANLETT

School of Public Health
University of North Carolina, Chapel Hill

Fifty sanitarians who received masters degrees with a major in sanitary science during the period 1946-1956 from the University of North Carolina in responding to a study of their activities revealed that while 41 of them remained in public health work only 29 were engaged exclusively as sanitarians. Changes in work responsibility were accompanied by increases in supervisory duties, increases in their salaries, and changes in their methods of meeting sanitation problems. Forty were certain that graduate education made their advancement easier. Of the fifty studied, 31 felt opportunities in sanitation to be good.

The number of sanitary science graduates at the master's level in the United States during the period 1926-1953 was 407, with 318 of these graduating between the years 1946-1953. The School of Public Health of the University of North Carolina graduated 63 of the 318 during the period noted (*1*). This number is more sanitary science graduates than any other school of public health produced during the same period. In the ensuing three years there were 7 additional graduates in this group from the University of North Carolina.

According to Greve and Campbell (*2*), 3,723 professional sanitarians were employed in the United States in 1951 by official health agencies in local areas. It is apparent that the percentage of sanitarians who have completed a program of graduate study in public health is very small. It is recognized that in the entire group there are other holders of masters degrees in specialized fields such as dairy science, entomology, and food technology. A study has been made of the seventy North Carolina graduates to determine the influence of graduate study on (*a*) their remaining in public health work, (*b*) their functioning exclusively as sanitarians, (*c*) their job responsibilities, (*d*) their salary increases, and (*e*) their attitude toward opportunities and advancement in sanitation.

These objectives were sought by the examination of the students' records at the University and by a questionnaire mailed to all of the seventy graduates. Inclusion in this group was determined by the position held by the man prior to entering school and by the course plan followed while at school. All of them completed a program in sanitary science designed for sanitarians in the Department of Sanitary Engineering and received either the degree Master of Public Health or Master of Science in Public Health during the period 1946-1956. Foreign-born students were not included in the group. No attempt was made to adjust for the differences that appear over a decade spread between men who graduated, for example, in 1947 as compared to those completing work in 1956.

The general composition of the group in terms of age, geographical origin and educational background is of interest. Approximately 22 per cent were under 25 years of age; 36 per cent, 25 to 29; 21 per cent, 30 to 34; and the remaining 21 per cent were over age 35. As would be expected in a school which is located in the Southeast, the states of that region contributed the greatest number of students. Fifteen came from North Carolina; 8 from Florida; 5 each from Georgia and West Virginia; 4 each from Virginia and Arkansas. Other states with a representation of more than one was made by 6 from New York, 3 from each of Missouri, New Jersey, and Ohio. Fourteen additional states were represented by one graduate, with a geographical spread touching all of the regions of the country with the exception of the West Coast.

An initial tabulation of the students' undergraduate majors showed a representation from 13 fields. Six of these may be grouped as biological science majors and include 41 per cent of the students, being the largest by a wide margin. Sixteen per cent had chemistry majors; 13 per cent were agriculture majors; and 10 per cent each from public health and general science majors. The 6 per cent from education and 4 per cent from sociology are the only ones which would not usually be considered to be undergraduates majoring in the sciences. However, at that time these men met the entrance requirement of approximately 30 semester hours of undergraduate work in the natural sciences.

RESPONSES TO THE QUESTIONNAIRE

Fifty men of the 70 who were mailed a three-page set of questions responded with usable returns. No

[1]Prepared from work carried out by Mr. John G. Todd as part of the requirements for the Master of Public Health Degree, University of North Carolina.

[2]Present address: Fayette County Health Deparmtent, Washington Court House, Ohio.

follow up letters were planned or made. This is a 71 per cent response. A higher level of response could have been secured by follow up techniques, particularly for those known to be in the immediate area. It is judged that the fifty reporting is sufficient in number and in character to give useful answers to the questions posed to University of North Carolina graduates.

Eighty-two per cent or 41 of the sanitarian group continue in some form of public health activity. Of these, 29 are exclusively carrying out the responsibilities of sanitarians. The remaining 12 are in such positions as industrial hygienist, chief chemist, food and drug inspector, public health dentist, state civil defense administrator, and co-director of state health services. Only one of these is in a voluntary health agency. Of the 9 who are no longer engaged in public health work, only 2 are in completely unrelated occupations. Others are in such activities as service in the armed forces, technical sales work, high school teaching, and advanced study in dentistry and zoology.

The question, *"Do you feel it important for a sanitarian to have a master's degree in public health?"* is a cardinal one. Eighty-four per cent of the respondents answered positively. Three of the 5 men giving a negative answer have left the field of public health. The reasons given by the 42 who answered affirmatively are as follows: 29 thought the advanced education enabled them better to understand public health and sanitation and to do a better job; 6 felt that the degree was important for advancement purposes; and 5 stated its usefulness for purposes of prestige or professional standing.

The negative responses were supported by such reasons as salaries paid are not in accord with time and effort to acquire a master's degree; graduate instruction too theoretical; required technical knowledge can be acquired in good undergraduate program; and the failure of a master's degree to change community attitude in not recognizing the sanitarian as a professional person.

Closely related is the question *"Do you feel the sanitarian with a master's degree in sanitary science has a better chance in public health than a sanitarian without the degree?"* Forty-five of the 50 respondents felt that the degree bettered their chances in public health. Three left the question unanswered and 2 felt that the degree made no difference or was of no benefit.

The reasons for the affirmative fall into three groups. Twenty-one felt that it was because they had a better understanding of public health and were better able to carry out their work; 17 felt that advancement would be much easier; and 5 felt that it gave them a better professional standing.

It should be noticed that the answers to these two questions are not wholly consistent, as in the first instance 6 of the 42 answering positively gave the supporting reason that the degree was needed for advancement. In the second instance, when the question is phrased in terms of having "a better chance," 17 of the 45 supported their affirmative answer with advancement as the reason.

A direct question was asked concerning *the value these graduates placed on graduate work*, with a rating of "none," "a little," or "great," to be checked. The rated questionnaires showed that 43 graduates felt their graduate work to be of "great" value and 6 felt their graduate education to be of "little" value. In comparison, the question was asked whether the graduates felt that their employer placed the same value on a master's degree as they did. Thirty-two of those answering felt that their employers placed about the same value on the degree as they themselves, and 15 felt the employers placed a lesser value on a degree than they did.

Changes in Salary, Responsibility, Work Methods and Professional Interests After Obtaining the Degree

It was found from this study that 72 per cent or 36 of the sanitarians returning the questionnaire received some salary increase within 6 months after receiving their master's degree. This salary increase was reported as follows: 19 per cent or 7 had an increase between $10-21 a month; 36 per cent or 13 had an increase between $21-50 a month; 17 per cent or 6 had an increase between $51-70 a month; and 28 per cent had an increase of over $70 a month. It is emphasized that approximately 60 per cent or 29 of the group felt that pay increases had been due primarily to having a master's degree, and that 80 per cent or 40 of them felt that graduate education had made advancement easier.

Since obtaining a master's degree, the respondents reported, *job responsibility* for 74 per cent or 37 of them has changed. Sixty per cent or 29 of them report acting more in a supervisory capacity than before receiving their advanced degree. Seventy-two per cent or 36 of this group reported that graduate education had changed the ways in which sanitation problems were solved.

To measure increased *professional interests*, the group was asked about membership in professional organizations. It was found that 68 per cent or 34 of them belong to more professional organizations than before graduate study. Of the 34, 14 belong to at least two more organizations, seven of the group be-

long to three more, and two belong to four or more professional organizations.

Discussion

The respondents reported substantial changes in the work responsibilities, in the extent of supervisory duties, and in the methods of solving sanitation problems. No refined analysis can be made of these changes from the data collected as there are differences within the group of lapsed time since graduation, and of the qualitative and quantitative experience of the men prior to entering graduate work. Further inquiry into these matters would be useful.

The data on salary changes within six months after graduation are gratifying as 72 per cent showed increases. These increases are regarded as substantial as for nearly 45 per cent of those receiving these had increments of over $50 a month. No detailed analysis was sought. It is not known whether the graduates had to make extensive job changes and relocations in order to secure such increases or whether these were the result of promotions for new qualifications and new responsibilities. The significant item to this study is that 29 of the 36 men who have reported salary increases did ascribe these as primarily due to having a master's degree.

The interest of sanitarians in achieving professional recognition is marked by such activities as the creation of registration boards and certification plans, the embracement of codes of ethics, and by the emergence of journals devoted exclusively to sanitation. The effect of graduate study on professional interest among this group was noted quantitatively by their joining professional organizations.

A further indication of professional allegiance is the readiness with which men recommend their work to others as a career. A report of the Committee on Educational and Professional Development of the International Association of Milk and Food Sanitarians, Inc., (3) showed that 73 per cent of the respondents recommended public health work as a career. Among the sanitarians here reported, 62 per cent expressed the feeling that opportunities in public health were good. The latter figure is regarded as somewhat low .

Study of graduate education of sanitarians on a wider base is needed. It should include a larger sample. It should permit analysis with adjustments for lapsed time since graduation, and for length of experience prior to graduate study. It should seek information in some detail on changes graduate study produces in the methods of meeting sanitation problems and of planning sanitation activities.

This examination of a small group of graduates from a single school is offered as an example and possible prototype. It may stimulate improved and extensive investigation of much larger and more representative samples of sanitarians throughout the country to determine how graduate education can be made more productive for the people who are served, for the organizations who employ sanitarians, and for the individual professional sanitarian.

Summary

1. In a questionnaire to 70 sanitary science graduates from the University of North Carolina School of Public Health, the school producing the greatest number of sanitary science graduates in the period 1946-1953, 50 responded, revealing 82 per cent as remaining in public health work.

2. Of the 41 respondents remaining in public health work, 29 have responsibilities which are exclusively those of sanitarians.

3. Of the 50 respondents, 37 report changes in work responsibilities with 29 stating increased supervisory duties.

4. Of the 50 respondents, 36 report an increase in salary within 6 months after graduation ranging from $10 to over $70 per month; and 29 ascribe pay increases primarily to having a master's degree.

5. Of 50 respondents, 31 judge opportunities in sanitation to be good; and 40 feel graduate education makes advancement easier.

Conclusion

The answers of 50 sanitarians who during a ten-year period completed a graduate degree program in sanitary science at the University of North Carolina show that they have performed well in public health careers, with 41 remaining in public health work, with reported increases in the scope of their responsibilities and changes in their methods of solving problems, and in securing greater compensation for their work. Graduate education has made their advancement easier and has increased their interests in professional societies. Professional opportunities as sanitarians in public health appear good to 62 per cent of the group.

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THE RELATIONSHIP OF MUNICIPAL ZONING TO PUBLIC HEALTH[1]

T. Edward Temple[2]

City Manager
Danville, Virginia

Public Health Defined

It would be well, at the outset, to define some terms that will be used during the course of this discussion. Quoting from Tobey's *Public Health Law* (1) the following definition of Public Health is given: *Public Health is the science and art of preventing disease, prolonging life and promoting physical health and efficiency through community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing service for the early diagnosis and preventative treatment of disease, and the development of the social machinery which will ensure to every individual a standard of living adequate for maintenance of health; organizing these benefits in such fashion as to enable every citizen to realize his birthright of health and longevity.*

You will immediately agree, I am sure, that this is an all inclusive definition and has stood the test of the years, and is a definition that sets forth the views of the average health officer as to the functions of public health.

Zoning Defined

Now the second term that will be used in this discussion should be defined and that is the word *zoning*. The supreme court of Connecticut once gave a very sensible definition when the court said, *zoning consists of the general plan to control and direct the use and development of property in a municipality or a large part of it by dividing it into districts according to present and potential use of the property.* With these two definitions in mind, I will now proceed with a discussion of the relationship between public health and zoning.

When one reads the preamble to any zoning ordinance, usually a general statement will be found to the effect that the ordinance is being adopted for the purpose of promoting health, safety, order, prosperity, historic resources, and the general welfare. Please note that health is first to be mentioned. The theory of zoning, it has been said, is to foster improvements by confining certain classes of buildings and uses to certain localities without imposing undue hardship on property owners.

Need for Zoning

Experience has shown that it is impossible for people to live effectively in a community without adequate zoning laws. Without adequate zoning, heavy industry often gets into a residential district, thus creating smoke, noise, dirt, and many other health problems. It is obvious, therefore, that the health of individuals living within this community is effected. Good zoning would attempt to prevent the intrusion of industry into a residential district.

Constitutionality

The question that is often asked by governing bodies and others interested in zoning concerns itself with the extent to which zoning is constitutional. During the course of this presentation, an attempt will be made to give you sufficient background to prove that zoning is legal. The legislature of our state has provided the legal tools with which to work. I refer to an Act of the General Assembly of Virginia as provided in Title 15, Chapter 24, Article 2, Section 15-844.

In view of the fact that many of you represent both rural areas and cities, I feel that this section will be of interest to you. In part it reads as follows: *Boards of supervisors are authorized to divide the area of a county in the unincorporated portions thereof into zones to regulate the use of land and buildings and other structures; to provide the locations of the areas which may be used as places of residence, or in which agriculture, forestry, trade, industry or other specific uses may be conducted; the height, bulk and size of buildings or other structures, the percentage of land area which may be occupied and minimum size of yards, courts, and other open spaces; and to provide for amendments and changes therein; to require county planning commissions to perform certain duties with reference thereto; to permit the appointment and prescribe the powers and duties of county boards of zoning appeals; and to provide methods for enforcement of this ordinance and penalties for the violation thereof.*

Background of Zoning

It may be of interest to review some of the history of zoning. A number of interesting decisions can be found; decisions that have been handed down by State Supreme Courts as well as by the United States Supreme Court. Mentioned earlier was a decision

[1]Presented before the Sanitation Sect. of Virginia Public Health Conference, Roanoke, Virginia, May 6, 1959.

[2]Read by Thomas M. Bay, Administrative Assistant, for the author.

rendered by the Supreme Court of the State of Connecticut. As one studies the history of zoning in America, it clearly establishes the struggle that has gone on through the years to protect the property rights of people. It has been stated that the late start of zoning in the United States has been attributed to many different causes, but the one most frequently mentioned, and perhaps most accurately, is the tendency of our courts, down through the years, to protect and preserve individual rights in property against the arbitrary control thereof by government. With the increase in size of American cities and urban counties, it is apparent that much harm has been done by our failure to enact regulations relative to the overcrowding of buildings on land and the unregulated use of land.

In fact as one observes the average American city today, he will find almost without exception areas where there is blight, overcrowding, lack of ventilation and light, all of which becomes a breeding place for disease. This indeed is the shame that has been brought to the average American city. The harm was done long before the first zoning ordinance was ever adopted.

Naturally a property owner wishes to know what benefits will be derived from zoning and often it is indeed difficult to convince the property owner of its value. However, we are now convinced and the courts have fairly well upheld this fact that the welfare of society transcends individual profit. In fact there have been fairly recent cases before the courts in which it was held that a land owner has no complaint though deprived of income by a zoning ordinance, unless said ordinance as applied to him was unreasonable and discriminatory and without relationship to public health, safety, morals or welfare.

Again your attention is called to the fact that the court places the same degree of emphasis upon public health as upon safety, morals or welfare. The courts will always hold an ordinance invalid when it clearly appears that the restrictions are unreasonable and have no substantial relation to the health, safety, welfare and convenience of the public. This, of course, is true whether the ordinance in question relates to zoning or any other proper subject for police power regulation.

The first test case in the United States Supreme Court of the right of a city to enact a comprehensive zoning ordinance arose out of consideration of the validity of an ordinance of the city of Euclid, Ohio. The court in this case upheld the validity of the ordinance.

ZONING AND PROPERTY VALUES

Before the advent of zoning in America, there were few regulations to prevent a property owner from using his property as he saw fit. Prior to that time there were only a few scattered fire and health laws. Many fine residential areas were injured by the frequent intrusion of business and factories. Into these vexing situations, came zoning laws and court decisions upholding them. These appeared as a silver lining to harassed property owners.

It has become more and more apparent, therefore, in this land where individuals love freedom that zoning itself has given the greatest amount of freedom and protection to the greatest number of people. Zoning has protected the health of people and property values. Good zoning has contributed to the orderly development of cities; has relieved cities of overcrowding, thus, making the average American city a more desirable place in which to live.

AUTHORITY FOR ZONING LAWS

The question that you may now ask is through what fundamental authority have zoning laws been passed. The answer is by an exercise of the police power of the state. How does such police power operate? The police power has been defined as one inherent in every sovereignty for the preservation of the public health, the public safety and the public morals. We must understand that the police power of a state or a locality is not something that is rigid and definitely fixed but in its very nature, it must be somewhat elastic in order to meet changing and shifting conditions which from time to time, arise through the increase in population and the complex commercial and social relations of the people. In the complexity of our present day life, there are so many factors connected with the health, safety and convenience of the community that the police power and regulations of wide scope are increasingly upheld.

One can hardly discuss this subject without asking very boldly who has the responsibility for zoning. In every county and city of the commonwealth it is the full responsibility of the governing body to see that adequate zoning regulations are passed for the protection of the people in that community. It is not intended to indicate that the governing body should attempt to zone in a dictatorial fashion, on the contrary it should be done in cooperation with the planning or zoning body of that community and with the citizens. There is no better person in a community to give leadership or certainly moral backing to the governing body in the adoption and enforcement of zoning regulations than the local health officer.

I think that zoning has been set apart from public health as such too long and it is now time that we begin to emphasize the importance of zoning in relationship to the promotion of public health.

STEPS IN ZONING

In conclusion, I should like to outline the methods to be used in establishing a zoning ordinance. It is necessary first to appoint a planning commission or zoning commission. This body will be responsible for drafting an appropriate zoning ordinance for the community and will make recommendations to the governing board. Briefly, zoning regulations start with the development of the zoning map which shows the exact boundaries between the different districts decided upon. The map usually shows the streets, highways, all property lines and natural streams, rivers and lakes since all of these things have been surveyed by engineers and have a known location on the ground. The zoning district boundaries are then fixed and so indicated. The map also makes clear each district with appropriate markings or colors. Each zone is given a name, such as agricultural zone, residential zone, retail business zone, etc. If it is decided to keep all future buildings back a certain distance from certain streets, then the set-back line must also be shown on the map.

The other part of zoning is the text which explains what the map means. It states just how the land in the zones or districts can be used or developed in the future. It lists, under the name or number of each zone, the kinds of property use permitted, the maximum height of buildings, the smallest size lot permitted, the rules on how close to a front, side or rear lot line a building can be built, and any other special rules that may be reasonable or desired. One of these special rules might be that every business should have a place on its lot for the customers to park, to keep parked cars off the highway where they may cause danger or interfere with traffic.

The text of the ordinance contains a section on how the regulations are to be enforced and establishes a penalty for breaking the laws. It must also set up a board of appeals, with power to allow some minor variations when the strict enforcement of the letter of the law would work a hardship on one man without doing anyone else very much good. It must always be remembered that good zoning regulations are clear, exact and easily understood. They should be as simple as possible and still do what the people in the community have decided they want to do.

As soon as the ordinance has been adopted, necessary funds must be appropriated for the establishment of machinery capable of enforcing the ordinance. The mistake should not be made of thinking that zoning enforcement can be handled in a haphazard manner. To enforce the ordinance an official must be appointed. He may be called a zoning administrator, zoning official, planning official—it matters not what is his title. He must be acquainted with the zoning ordinance, understand good zoning practices and, above all, be able to be firm yet fair in the enforcement of the law. Of course, the law makes provision for appeals from the decision of the zoning administrator. It is his duty, however, to see that the ordinance is fairly and firmly enforced.

Those of you who are working in communities where zoning laws are inadequate must be willing to recognize the value of such laws as tools in the field of public health. You are qualified by training to understand the importance of zoning. You should give leadership whenever and wherever possible.

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ANTIBIOTIC RESIDUES IN MILK AND MILK PRODUCTS—A REVIEW

E. H. Marth and B. E. Ellickson

Research and Development Division
National Dairy Products Corporation
Glenview, Illinois

Introduction

Antibiotic therapy has been employed by farmers and veterinarians for over a decade in the treatment of infectious diseases of dairy cattle the most common of which, undoubtedly, has been mastitis. In some instances, the drugs have been incorporated into feed as a dietary supplement. Such uses have led to the presence of antibiotic residues in milk and subsequently to industry-wide problems.

This paper will attempt to summarize available information on: (*a*) the presence of antibiotics in the milk of treated cows, market milk and milk products; (*b*) effects of some manufacturing processes on antibiotic residues in milk and milk products; (*c*) measures suggested for reduction of antibiotic residues in milk; and (*d*) the attitude of the Food and Drug Administration on the presence of antibiotics in milk and milk products. Problems created by the presence of antibiotics in milk and milk products will be discussed in another paper (*46*).

Antibiotics Administered By Intramammary Infusion

Kinds Used

Antibiotics, regardless of kind, are most commonly administered to mastitic animals in a solution or suspension which is infused into the infected quarter or quarters of the udder.

Penicillin, perhaps, was the first of a series of antibiotics employed in mastitis treatment. Its use was suggested in 1946 (*35*) and regularly since then (*33,38, 40, 45*). According to a recent survey (*70*) penicillin was found in market milk more frequently than any other antibiotic.

Other antibiotics suggested for use in the treatment of mastitis are: streptomycin (*39, 51, 66*) chlortetracycline (aureomycin) (*23, 27, 39, 42, 43, 51*), oxytetracycline (*2, 51*), bacitracin (*6, 39*), neomycin (*1*), subtilin (*39*), chloramphenicol (*39*) and polymyxin (*70*).

Combinations of antibiotics have also been suggested for the treatment of mastitis. A test of three different mixtures (*68*) showed that a combination of neomycin and penicillin was most effective of those tested. A mixture of neomycin, bacitracin and penicillin was second in effectiveness while a combination of neomycin and bacitracin was least effective of those tested.

A recent survey (*70*) indicated that antibiotics other than penicillin were found in market milk but in fewer instances. Those found included: streptomycin, bacitracin, one of the tetracyclines or a combination of these antibiotics.

A study on vehicles used to carry antibiotics for mastitis treatment has shown that penicillin diffusion into milk was greatest when the antibiotic was contained in a base composed of liquid and white petroleum (*57*). The addition of beeswax to the base decreased the rate of diffusion.

Levels Used

The quantity of antibiotic used for an individual udder infusion varies according to: (*a*) the kind of antibiotic used; (*b*) the severity of the infection; (*c*) the frequency with which the antibiotic is to be administered during the course of treatment; and (*d*) the judgment of the person administering the antibiotic.

Considerable variation can be noted in the sizes of dosages of antibiotics suggested by various investigators for intramammary infusion in the treatment of mastitis. Suggested levels of penicillin range from less than 10,000 units (*3, 4*) to 300,000 units (*33*) with the most frequently reported dosage as 50,000 units (*10, 36, 51, 56*). Streptomycin dosages reported for use per infected quarter include five to 25 mg. (*66*), 200 mg. (*30, 51*) and 100 to 500 mg. (*62*). Single udder infusions of 200 mg. (*5, 8, 9, 51*) and 400 mg. (*37*) of chlortetracycline per quarter have been reported.

Single doses of 200 mg. of chloramphenicol (*51, 54*) and 200 mg. of oxytetracycline (*51*) per quarter have been used in mastitis therapy.

Best results were obtained with bacitracin when 100,000 units were infused into the infected quarter three times at 24 hour intervals (*6*).

Levels and Persistence in Milk from Treated Cows

After an antibiotic is infused into the udder for the treatment of mastitis some of it may be absorbed by the tissues of the udder and appear in the blood. Concentrations of 0.08 to 0.10 ug. per ml. were found in the blood serum 12 hours after 400 mg. of chlortetracycline was infused into one quarter of the udder of a cow (*37*). Further evidence of absorption by tissues is provided by studies which showed that some of the antibiotic infused into the udder was

TABLE 1 — PENICILLIN RESIDUES IN MILK FROM TREATED COWS AS REPORTED BY VARIOUS AUTHORS

TREATMENT Units/Treatment	PENICILLIN RESIDUES IN MILK Time Counted From Last Treatment (Units/ml. milk)		REFERENCE
5,000-25,000-3X[a]	12 hrs.:	1-10	*3,4*
20,000-1X	12 hrs.: 24 hrs.:	3.0-4.5 0.2-0.4	*38*
25,000-1X	24 hrs.:	14.0	*62*
25,000-1X	12 hrs.:	2-6	*48*
25,000	12 hrs.:	4.1	*65*
25,000-1X	24 hrs.:	+[c]	*33*
50,000	12 hrs.: 24 hrs.: 36 hrs.:	+ ± −	*36*
50,000-3X	72 hrs.:	>0.05	*55*
50,000-2X (100% of herd)	48 hrs.: 72 hrs.:	0.39-pooled milk 0.14-pooled milk	*10*
50,000-2X (50% of herd)	48 hrs.: 72 hrs.:	0.27-pooled milk 0.05-pooled milk	*10*
50,000-2X (25% of herd)	48 hrs.: 72 hrs.:	0.08-pooled milk 0.02-pooled milk	*10*
50,000-1X	8 hrs.:	+	*50*
75,000-1X	12 hrs.	+	*44*
100,000[b]-1X	72 hrs.	+	*73*
100,000	84-144 hrs.:	+	*18*
3000,000[b]-1X	72-192 hrs.:	+	*33*

[a]Indicates number of treatments administered at indicated level.

[b]Procaine penicillin in oil with aluminum monostearate was used.

[c]Plus (+) sign indicates presence of detectable level of penicillin but quantitative values were not given.

subsequently voided in urine by the cow (*26*).

The portion of infused antibiotic which is not absorbed by udder tissues is voided in milk and the quantity varies as to the individual cow. A comparison of two cows (*29*) showed that one excreted 2.7 per cent and another 84 per cent of the amount of antibiotic infused into the udder. The average rate of excretion was listed at about 40 per cent. Hargrove, *et al.* (*25*) found that 26 to 49 per cent of infused penicillin and 39 to 58 per cent of infused streptomycin was excreted in milk obtained from cows after treatment.

Other factors which influence the quantity of antibiotic in milk from treated cows (*17*) are the following: (*a*) concentration and kind of antibiotic used; (*b*) the carrier or vehicle employed in the antibiotic preparation; (*c*) the amount of milk drawn from the gland; and (*d*) the time interval between treatment and milking.

The results of various studies on the presence of penicillin in the milk from cows treated for mastitis by means of udder infusion are summarized in Table 1.

Considerable variation existed in treatments given animals by the different investigators, but the following generalizations can be made from a study of the results:

(a) There probably was some variation in the amount of penicillin excreted in the milk by individual cows. This is evidenced by the reported ranges of residual antibiotic in milk (*3, 4, 18, 33, 38, 49*) and is in agreement with the work cited above (*25, 29*).

(*b*) Highest concentrations of penicillin were found in the milk removed from the udder during the first 24 hours after treatment (*36, 38*).

(*c*) The use of higher concentrations of penicillin in treatment resulted in the presence of the antibiotic in the milk from treated cows for longer periods of

time. Dumais (*18*) used 100,000 units of penicillin for treatment and found detectable levels of penicillin in the milk from treated cows 84 to 144 hours later. Jackson and Bryan (*33*) used 300,000 units for treatment and found penicillin residues in milk from treated cows 72 to 192 hours later. In evaluating their results (*33*) it must be remembered that they used penicillin in an oil suspension with added aluminum monostearate to prolong the maintenance of therapeutic antibiotic levels in the udder.

(*d*) The duration of penicillin in the udder was influenced by its carrier. Several investigators (*33, 74*) found that procaine penicillin in oil with added aluminum monostearate served to extend the period during which penicillin was detected in the milk of treated cows. Experiments of Foley, *et al.* (*20*) further substantiate the importance of the vehicle in determining the length of time that penicillin remains in the udder. They found that when penicillin was incorporated into a mixture of mineral oil, water, lanolin, propylene glycol derivatives and a non-ionic wetting agent it lasted longest in the udder and 0.4 to 4 units were present per ml. of milk after 72 hours. When the vehicle consisted of mineral oil, water and lanolin, 1.5 to 20 units per ml. of milk were detected after 36 hours and when the vehicle was water, none was detected at that time. Hughes, *et al.* (*31*) reported that procaine penicillin, when infused into the udder, persisted for about 12 hours longer than did calcium penicillin.

(*e*) The work of Broggler, *et al.* (*10*) indicated that if a moderate dose of penicillin (50,000 units) was administered, a significant amount (0.14 units/ml) was detectable in milk from the treated animal 72 hours later.

Results of several investigations on residual streptomycin in the milk from udders of cows treated for mastitis by means of streptomycin infusion are summarized in Table 2. Streptomycin residues have been reported as present in milk for as long as 72 hours after treatment (*51*). Other workers (*62, 66*) have reported that significant levels of streptomycin were found in milk 12 and 24 hours after the animal was treated.

TABLE 2 — STREPTOMYCIN RESIDUES IN MILK FROM TREATED UDDERS OF COWS AS REPORTED BY VARIOUS AUTHORS

TREATMENT[a] Mg./Treatment	STREPTOMYCIN RESIDUE IN MILK Time Counted From Last Treatment (ug./ml. of milk)		REFERENCE
50-250	2 hrs.:	35.4	*65*
	12 hrs.:	9.7	
100-500	24 hrs.:	>20	*61*
200	8-72 hrs.:	+[b]	*50*
250	8 hrs.:	+	*30*

[a]A single dose was administered for the complete treatment.

[b]Plus (+) sign indicates presence of detectable level of streptomycin but quantitative values were not given.

TABLE 3 — CHLORTETRACYCLINE RESIDUES IN MILK FROM TREATED UDDERS OF COWS AS REPORTED BY VARIOUS AUTHORS

TREATMENT[a] Mg./Treatment	CHLORTETRACYCLINE RESIDUES IN MILK Time Counted From Last Treatment (ug./ml. of milk)		REFERENCE
100-200	48 hrs.:	0.64-5.1	*47*
200	12 hrs.:	3.5-25.0	*8, 9*
200	12 hrs.:	20	*5*
	72 hrs.:	0.66	
200	8-96 hrs.:	+[b]	*50*
400	12 hrs.:	50-400	*37*
	48 hrs.:	1-10	

[a]A single dose was administered for the complete treatment.

[b]Plus (+) sign indicates presence of detectable level of chlortetracycline but quantitative values were not given.

Table 3 summarizes the results of various studies on residues of chlortetracycline in milk from cows treated by intramammary infusion of the antibiotic. From this table it can be seen that: (*a*) chlortetracycline persisted in the milk of treated cows for 96 hours (*51*); (*b*) higher levels of antibiotic were present in milk at 12 and 48 hours after treatment when a higher initial dose was used (*5, 8, 9, 48*); and (*c*) variation existed between cows in the amount of antibiotic excreted as evidenced by the ranges of antibiotic in the milk reported by three of the five authors (*8, 9, 37, 48*).

Barnes (*2*) studied the use of oxytetracycline in the treatment of bovine mastitis. When normal quarters received one infusion of 400 mg. of oxytetracycline, the antibiotic persisted in the udder for an average of 37.3 hours after treatment. The use of three treatments of 400 mg. of oxytetracycline administered at 24 hour intervals resulted in the presence of detectable amounts of the antibiotic in the udder for an average of 45.3 hours. The persistence of the drug in the udder was increased to 54 hours when three infusions of 800 mg. of oxytetracycline each were administered at 24 hour intervals. Barnes (*2*) further reported that: (*a*) variations in concentrations of residual oxytetracycline occurred in milk from different quarters of the same cow as well as from different cows; and (*b*) there was no consistent accumulation of the drug in the udder as shown by the concentration of residual antibiotic attained in the

milk or by the time needed for the udder to clear itself of the antibiotic after treatment.

ANTIBIOTICS ADMINISTERED BY OTHER METHODS AND THEIR OCCURRENCE IN MILK

Antibiotics for the treatment of mastitis are most commonly administered to dairy cows by means of intramammary infusion. These drugs, however, can be and often are used for the treatment of infectious diseases other than mastitis and then may be administered by injection. Antibiotics may also be administered to dairy cattle orally either for treatment of disease or as a feed supplement.

Injected

Two cows were injected subcutaneously with an initial dose of 5,000 units of penicillin per pound of body weight and with three later doses of 2,500 units per pound of body weight given at six hour intervals (*73*). The antibiotic level in the blood 15 minutes after the initial injection was eight units per ml. which decreased to 0.5 units per ml. in five hours. After each later injection, the antibiotic level per ml. rose to two, two and one units at the seventh, 14th and 19th hours respectively. The level of penicillin in milk after 15 minutes was less than 0.05 unit per ml. but after five hours had risen to 0.84 unit per ml. After the second injection, there was 0.78 unit per ml. and this value rose slightly after each subsequent injection. The milk, 30 hours after the final injection, contained 0.06 unit of penicillin per ml. Results obtained by Sadek (*53*) indicated that when penicillin was administered to a cow either subcutaneously or intramuscularly at the rate of 5,000 units per pound of body weight, the penicillin appeared in the milk at a level of at least 0.032 unit per ml. for 24 hours with twice a day milking. These data differ somewhat from an earlier report (*27*) in which it was claimed that the udder is not a major systemic outlet for penicillin in the blood.

Barnes (*2*) reported that oxytetracycline could not be demonstrated in milk from cows which had received intramuscular or intravenous injections of one gram doses.

Fed

Chlortetracycline was fed to cows at the rate of 390 mg. per cow per day in work reported by Martin, *et al.* (*61*). No detectable amount of chlortetracycline was found in the milk from any of the cows fed the antibiotic and no significant difference was noticed in numbers of bacteria present in their milk.

Different groups of dairy cows were fed 0.1, 0.5 or 1.0 mg. of chlortetracycline per pound of body weight per day by Henderson, *et al.* (*28*). They found the antibiotic present in detectable amounts in the blood and milk of the cows which received either the 0.5 or one mg. level of chlortetracycline.

LEVEL OF RESIDUAL ANTIBIOTICS IN MARKET MILK AND MILK PRODUCTS

The quantity of antibiotic present in milk drawn from treated udders of cows has previously been discussed in this paper. When the milk from antibiotic treated animals (intramammary, orally, injected) is added to the milk of untreated animals, the antibiotic in the former is diluted by the latter and hence the quantity of antibiotic in "market milk" is different from that in the milk from treated animals. The quantity of antibiotic in a given volume of market milk will depend on: (*a*) the number of treated and untreated cows whose milk makes up the total; (*b*) the amount of milk produced by both treated and untreated cows; (*c*) the quantity of antibiotic used in treatment; (*d*) the vehicle carrying the antibiotic; and (*e*) the time elapsed between treatment and addition of milk from the treated animal to the market milk supply (*15, 17*).

Market Milk

A series of recent surveys in the United States, Canada and Great Britain have been conducted to determine the quantity of antibiotics in market milk supplies.

Perhaps one of the first reported surveys of antibiotics in market milk was conducted in New York State in 1951 (*41*). A total of 1,794 samples of fresh, blended and pasteurized whole milk were obtained from dairy plants or route wagons in 36 counties. Six per cent of the samples tested contained antibiotics and they were present in the range of 0.05-0.1 unit per ml. of milk. Penicillin was found most frequently and most antibiotics appeared in the milk during the spring of the year.

During the years, 1954, 1955 and 1956 three U. S. surveys of fluid milk supplies were made by the Food and Drug Administration to determine the degree of antibiotic contamination.

The first survey (*70, 72*) was made on both raw and pasteurized milk obtained from seven of the 16 Food and Drug Administration districts and showed that 3.2 per cent of 94 samples contained penicillin and 1.07 per cent contained bacitracin.

The second survey (*72*) was more extensive than the first since milks were obtained from all 16 of the Food and Drug districts. A total of 474 samples were examined and 11.6 per cent were found to contain penicillin in amounts ranging from 0.003 to 0.08 unit per ml. of milk. One sample was found to contain tetracycline.

A total of 1,706 samples of raw and pasteurized

market milk from each of the 48 states and the District of Columbia were checked for antibiotic residues in the third survey (*70, 71*). Penicillin, in concentrations of 0.003 to 0.55 unit per ml. of milk was found in 5.9 per cent of the samples. Seventeen other samples contained bacitracin, one of the tetracyclines or a combination of two of these drugs.

Shahani, *et al.* (*60*) conducted a smaller survey and found that critical concentrations of antibiotics were present in 1.3 per cent of 151 raw milk samples obtained from individual dairy herds.

A survey (*50*) was conducted in 1954 to determine the incidence of starter inhibitors in individual herd milks delivered to 30 dairy plants in Dane, Dodge, Columbia and Manitowoc Counties, Wisconsin. It was found that 4.3 per cent of all the milks tested contained substances which significantly reduced the activities of starter cultures. When the samples were divided on the basis of type of milk plant to which they were delivered, it was found that: (*a*) 5.5 per cent of the milk delivered to cheese factories contained substances which inhibited starters; (*b*) 3.9 per cent of the milk delivered to fluid milk plants contained inhibitory substances; and (*c*) 1.3 per cent of the milks delivered to condenseries contained inhibitory substances. These substances were believed to be primarily antibiotics.

The presence of antibiotics in milk has also been reported outside the United States. A Canadian survey (*34*) showed that starter cultures were inhibited by 7.3 per cent of 344 herd milks sampled in the summer of 1952.

Surveys were carried out in Great Britain (*64*) during the summer of 1951 and the winter of 1953. Results obtained in 1951 showed that 1.4 per cent of samples from herd milk in one test and 2.8 per cent in another test contained from less than 0.25 unit to 15.0 units of penicillin per ml. of milk. Work in 1953 showed that 3.2 per cent of the samples obtained from herd milk contained between 0.1 and 1.17 units of penicillin per ml. of milk.

Results from surveys conducted in Great Britain during 1954 and 1955 (*7*) showed: (*a*) there was no seasonal trend in the quantity of penicillin in milk; (*b*) of 143 raw milk samples taken from cheese vats, weigh tanks and transport tankers, 2.5 per cent contained 0.4 or more units of penicillin per ml. of milk and 15 per cent contained 0.01 or more units of penicillin per ml. of milk; and (*c*) of 575 samples taken from herd milk, 5.35 per cent contained 0.01 or more units of penicilin per ml.

Other Dairy Products

Information is limited on antibiotic residues in dairy products other than milk. No antibiotic residues were found in cheese, butter, dried milk and evaporated milk by the Food and Drug Administration in a survey made in 1954 (*70, 72*). Work reported by Hansen, *et al.* (*23*) showed that antibiotics were present in a dried milk made from a milk mixture which contained one per cent milk from cows whose udders were recently treated with antibiotics.

Samples of whey and dried skim milk were analyzed for the presence of residual penicillin by Hagen and Ellickson (*22*). They found from 0.05 to 0.10 unit of penicillin per ml. in those samples of whey which contained the antibiotic. Penicillin-positive samples of dried skim milk contained between 0.5 and 2.5 units of penicillin per gram.

EFFECTS OF SOME MANUFACTURING PROCESSES ON RESIDUAL ANTIBIOTICS IN MILK

After raw milk leaves the farm and arrives at the dairy plant, it is subjected to various manufacturing processes before it reaches the consumer. Most common of these processes are: (*a*) various heat treatments as found in pasteurization, evaporation and drying; (*b*) freezing; and (*c*) concentrating effects of drying, evaporation and separation. Since various components of milk are affected by some or all of these treatments, it is possible that antibiotics, if present, may also be affected.

Heat Treatments

The effect of various heat treatments on the activity of penicillin in milk is summarized in Table 4. The work of these authors indicates that penicillin in milk was quite stable to heat and that pasteurization temperatures and times commonly applied to milk and milk products were inadequate for the destruction of the antibiotic if it was present. Some discrepancies exist among the various results obtained at boiling temperatures or above. The data indicate, however, that a portion of the penicillin activity in milk survived boiling for 60 minutes and autoclaving at 15 p.s.i. steam pressure for 15 to 30 minutes.

Antibiotics other than penicillin which may be in milk are also quite heat resistant. It was reported (*39, 42, 43*) that chlortetracycline was not inactivated by heat treatments of 145° F. for 30 minutes, 190° F. for 60 minutes or 250° F. for 15 minutes. Pasteurization of milk which contained antibiotics did not inactivate any of the following: chlortetracycline, chloramphenicol, streptomycin and oxytetracycline (*51*).

Shahani (*59*) reported a reduction of 9.3, 14.2, 18.4, 22.5 and 25.4 per cent in the potency of chlortetracycline in milks which were pasteurized at 143° F. for 10, 20, 30, 40 and 50 minutes, respectively. The loss in potency was 13.5, 20.1, 27.1, 32.5 and 38.2 per cent when milks were pasteurized at 160° F. for the same time periods. More recently he (*58*) found

TABLE 4 — THE EFFECT OF VARIOUS HEAT TREATMENTS ON THE ACTIVITY OF PENICILLIN IN MILK AS REPORTED BY VARIOUS AUTHORS

Heating Temperature (°F.)	Time of Exposure (min.)	RESULTS OBTAINED	REFERENCE
140	30	5-30% inactivation[a]	*21*
143	30	Not destroyed	*44*
145	30	Not destroyed	*39*
154.4	10	No effect	*64*
160	1705	Complete inactivation	*60*
185	10	No effect	*64*
190	60	Not destroyed	*44*
190	420	Complete inactivation	*60*
190.4	30	No effect	*64*
200	230	Complete inactivation	*60*
212	15	No effect	*68*
212	30	50% inactivation	*68*
212	60	50% inactivation	*32*
212	60	75% inactivation	*68*
239	10	Complete inactivation	*64*
240	15	Not destroyed	*44*
250	15	Not destroyed	*44*
250	15	73% inactivation	*39*
250	25	Complete inactivation	*60*
250	30	Slight inactivation	*54*

[a]Penicillin contained in aqueous solution instead of milk.

that pasteurization at 143° F. for 30 minutes resulted in a 30 per cent loss of oxytetracycline activity when 0.84 to 1.0 ug. of the antibiotic was present per ml. of milk. An increase in pasteurization temperature to 160° F. resulted in a 40 per cent loss in activity after 30 minutes of heating. Oxytetracycline in milk was found to be completely inactivated by heating to 160° F. for 190 minutes, 175° F. for 92 minutes and 185° F. for 60 minutes.

Freezing

Information about the effects of freezing on residual antibiotics in milk and milk products appears to be lacking in the literature.

Concentrating

The separation of milk into cream and skim milk did not result in a concentration of either penicillin or streptomycin in one of the two fractions (*23*). It was found (*52*), however, that chlortetracycline was concentrated in the skim milk fraction of milk from treated cows. During the first four to five milkings after treatment, the antibiotic was most concentrated in the filtrate which remained after the casein and albumin were removed from the skim milk. Later milkings showed the opposite to be true.

Hansen, *et al.* (*23*) reported antibiotic activity in dried skim milk powder made from a mixture which contained one per cent skim milk from quarters of treated cows. Hagen and Ellickson (*22*) found penicillin in some samples of commercial dried skim milk. A Food and Drug Administration survey conducted in 1954 (*70*) showed that no antibiotic activity could be demonstrated in test samples of dried and evaporated milk.

SUGGESTED REMEDIAL MEASURES

Perhaps the single best way to eliminate the problem of the presence of antibiotics in milk is simply to keep the antibiotics out of the milk supplies. This means that milk from treated animals should not be included in the milk supply until it is free from antibiotic residues. The period of time required for elimination of the antibiotic from the milk varies as to: (*a*) kind and concentration of antibiotic used; (*b*) stage of lactation of the cow; (*c*) quantity of milk produced; and (*d*) severity of the infection. Various recommendations have been made on the period of time which should elapse between the treatment of a mastitic quarter with an antibiotic and the inclusion of milk from that quarter in the general milk supply. A two day waiting period has been suggested if chloramphenicol is used (*15, 51*) and a three day waiting period if penicillin (*11, 56*), streptomycin (*50*) or oxytetracycline (*51*) is used for treatment. A four day waiting period has been suggested if penicillin (*38*) or chlortetracycline (*51*) is used. Krienke (*42, 43*) reported that chlortetracycline in concentrations inhibitory to lactic starter cultures was present in milk from some cows, six days after treatment.

A program to acquaint farmers with problems caused by antibiotics in milk has been suggested (*12*). This program is, perhaps, even more necessary today and should be a joint effort by: (*a*) county and state extension personnel; (*b*) dairy plants; (*c*) veterinarians; (*d*) pharmaceutical companies; (*e*) agricultural magazines; and (*f*) radio and TV stations which carry farm programs.

Restricted sales of antibiotics for mastitis treatment might, perhaps, reduce antibiotic contamination of milk in some instances but it is more than likely that the overall picture would be little affected. It makes little difference who administers the antibiotic, farm-

er or veterinarian, if the milk from treated quarters is not withheld from the market for a sufficient period of time.

The addition of a dye to preparations used for treatment of mastitis has been suggested (*70*). This dye would be secreted in the milk for several days after treatment and serve to insure that milk from treated animals is not included in the general supply. The use of a combination of fat-soluble fluorescein and uranine has recently been suggested for such purposes (*24*). Such dyes could be detected visually in the milk for 48 hours after treatment and with ultraviolet light for 96 hours.

The Food and Drug Administration, in the summer of 1957, took two steps in an attempt to reduce quantities of penicillin residues in market milk (*16*). They required that: (*a*) packages of penicillin preparations to be used for mastitis treatment be labeled with a warning to the producer not to use the milk from an animal just treated; and (*b*) quantities of penicillin per individual package of preparation for mastitis treatment be limited to 100,000 units. Previously warning statements appeared only on the brochure packed with the penicillin preparation and no limitations existed on the quantity of antibiotic in the preparation.

ATTITUDE OF FOOD AND DRUG ADMINISTRATION

It has been suggested by Welch (*67*) that milk from antibiotic treated quarters of mastitic dairy cows is doubly adulterated, first by the infectious material present and secondly by the antibiotic.

The view of the Food and Drug Administration in regard to the presence of antibiotics in foods has been summarized in a policy statement issued November 30, 1955 and reported by Durbin (*19*) as follows:

"Direct or indirect addition of antibiotic drugs to foods for human consumption: (*a*) The Food and Drug Administration has received inquiries concerning the use of antibiotic drugs as food preservatives. Careful consideration has been given to this question and the conclusion has been reached that such use constitutes a public health hazard. Consumption of food so treated may cause sensitization of the consumer to such antibiotics and may result in the emergence of strains of pathogenic micro-organisms resistant to these drugs. (*b*) The presence of antibiotic drugs in foods intended for human consumption, or the direct or indirect addition of such drugs to such foods, may be deemed an adulteration within the meaning of section 402 of the Federal Food, Drug and Cosmetic Act. (*c*) This statement of policy will not bar the establishment of safe tolerances for antibiotic drugs in or on raw agricultural commodities under the provisions of section 408 of the Act, where suitable evidence of usefulness of the antibiotic drugs and of safety of residues is available."

SUMMARY

Antibioitcs have been used in dairy cattle management for more than a decade. They are administered to cattle by: (*a*) infusion into the udder for treatment of mastitis; (*b*) injection (intramuscular, intravenous or subcutaneous) for treatment of numerous diseases; and (*c*) orally for treatment of diseases or as a dietary supplement. Such uses have led to the contamination of milk and milk products with antibiotics. The Food and Drug Administration considers antibiotic-contaminated milk as adulterated. Such adulteration can be minimized by exclusion of contaminated milk from the general milk supply. The Food and Drug Administration has attempted to reduce adulteration by limiting the quantity of penicillin in each package of preparation to be used for mastitis therapy and by the requirement that a warning against the use of milk from recently treated animals be placed on the package.

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RECENT DEVELOPMENTS IN AUTOMATIC CLEANING OF STORAGE TANKS*

V. E. Meyers, Chief Engineer

Girton Manufacturing Co.
Millville, Pennsylvania

Automatic cleaning means mechanical cleaning. When successful mechanical cleaning is being done, it is possible, by instrumentation and control, to automatize the cleaning system to any desired degree.

Different ideas seem to exist as to what clean means, as it applies to dairy equipment. In this discussion we mean a tank that is clean, as demanded by all sanitary standards.

Several devices have been used to clean storage tanks by mechanical methods. We should examine these devices and see how each one is supposed to operate.

Cleaning With Spray Ball

Spray balls have been installed in more storage tanks than any other device. Some have been installed as a permanent part of tank equipment. Others have been designed to be placed in the tank when the cleaning operation is started. Both types of spray balls are expected to do the same cleaning job, so they will be grouped together. These spray balls have been placed on piping extending down from the top of the tanks, on horizontal piping welded to the tank liner and on piping that rests on supports standing on the bottom of the tank. They have generally been self-draining. In fact, they have to be self-draining and self-cleaning if they are to be successful. Some spray balls are made in two sections which are separable and can be taken apart for cleaning. Other spray balls have a plastic ball installed inside, made to bounce around by the solution flow, and keep the inside of the ball clean.

Recently, variations of the spray ball have been designed and installed in storage tanks. Generally they are not spherical in shape, but are supposed to do the same job as the regular spray balls.

The spray balls and variations of them have given varying results. A pump to supply pressure to the cleaning solutions has been attached to the spray ball piping system. These spray balls have been used in all sizes and shapes of tanks. Generally speaking, a single spray ball has been installed for each eight feet of tank length. This has been a general rule and is not true in all cases. They have been placed at different distances from the bottom and from the top of the tanks.

Spray Unit

The second device that has been used is the hot spray unit. This consists of a tank, a hoze, nozzle and a pump. A solution is prepared in the tank, and it is heated and sprayed on the tank surface. The hot solution is allowed to remain on the surface for a short time. A respray with the hot solution follows and then rinsing with fresh water as the last treatment. A man must enter the tank to properly apply the cleaning solution.

Injector Unit

The third cleaning device is the injector type of hot spray unit. This consists of a detergent reservoir tank, a venturi element and a mixing valve with hose and nozzle. The tank is filled with detergent and connected to a water supply. The water flows through the venturi and draws detergent from the supply tank and mixes the solution. The nozzle is then controlled by the man who sprays the surface to be cleaned.

Rotary Sprayer

The fourth device is the rotary type sprayer. It has a rotating head, driven by a motor, fitted with a number of spray nozzles. These nozzles are supposed to overlap and completely cover the inside surfaces of the tank. This sprayer requires a pump to circulate the cleaning solution through the spray nozzles.

Rotating Nozzle

The fifth device consists of a rotating nozzle equipped head. It is rotated by the jet action of one or more of the spray nozzles. This device has the spray patterns designed to overlap on the tank surface. The rotating mechanism has been made with sleeve type bearings and, more recently, with stainless steel ball bearings. This unit requires a fixed pressure system, to insure positive and constant speed of rotation. Usually, it has been installed in the top of storage tanks. Not many of these cleaning devices have been installed in tanks.

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ROTATING HOLLOW SHAFT

The sixth cleaning device consists of a rotating hollow shaft that extends down through the top of the storage tank. A fan shaped slotted jet is attached to the hollow shaft. Cleaning solutions, under pressure, flow through the hollow shaft and out through the slotted jet. Because the slotted jet throws a fan shaped pattern of cleaning solution, an uninterrupted stream of solution is placed on the top surface of the tank liner. As the jet assembly rotates, complete coverage of the tank interior is accomplished with each revolution of the jet. Normally, this mechanism rotates five times per minute. This means that five times per minute the entire interior of the tank is covered with cleaning solution.

This rotating slotted jet has also been installed as an integral part of the agitator shaft. It is designed to allow normal use of the agitator without any adjustment. When the cleaning operation is started, solution is pumped through an inlet on top of the tank. The cleaning solution flows through the hollow shaft and out through the slotted jet. This fan shaped pattern of solution covers the upper surfaces to be cleaned and flows down the sides and ends. An opening in the device allows solution to flow down the agitator shaft and thoroughly clean the shaft and upper blade or blades. The bottom agitator blade, or blades, and the bottom bearing are cleaned by rotating in the pool of cleaning solution that collects on the bottom of the tank. This solution is drawn out through the outlet and discharged to the drain or used again.

These devices have been used for cleaning storage tanks, and different ideas exist as to their cleaning efficiency.

CLEANING PROCEDURES

Probably the best way to clean a storage tank by mechanical means would be to proceed as follows:

Fill the tank with water, add the proper chemical to make a good cleaning solution, heat the solution to the proper temperature and shake the tank until the soil is removed from the cleanable surfaces. The only problem is to find a man strong enough to pick up a storage tank and shake it. By accepting this method as the perfect one, we can then consider these mechanical cleaning devices and see how they approach perfection. Certainly, it is safe to assume that good chemicals are available to do the cleaning job. Water and methods of heating are at hand. Pumps, tanks and controls are all presently available. All the different devices can easily be installed in tanks. Now, all that remains is for the mechanical devices to completely cover the surfaces to be cleaned with cleaning solution.

The Spray Ball Method can do this, if it is properly installed and if the proper pressure and volume of cleaning solution is supplied to its inlet. Also provided, and this is very important, that the storage tank has been designed to be cleaned by mechanical means. A four inch diameter spray ball can have any number of holes drilled in its surface, through which the cleaning solution is discharged. To work at all, these balls must be some distance from the surface to be covered. Otherwise, the solution would all strike the surface to be covered in a small area. As the distance increases between the spray ball and the surface to be cleaned, the streams of solution get farther apart. This means that the solution has to bounce or slide across the area between these impact points. It is quite difficult to control this bounce or slide, and again, proper installation should be stressed. If the tank has a Vertical Agitator Shaft, the spray ball has a difficult time in covering the back side of the shaft. It is very hard to cause water to bounce, slide or go around corners, into blind spots, bearings or around any obstructions in the tank. The results from spray ball installations indicate that extreme care must be taken to insure that successful cleaning will result.

The hot spray system of cleaning tanks can do a good job, but it is still a manual operation. It requires the same attention to chemical solution, temperature and time to insure success. This operation also requires that a man go inside the tank and limits its usefulness as a mechanical method of cleaning storage tanks.

The injector system of hot spraying is essentially the same as the pump type system mentioned previously.

It should be mentioned here that some air agitated tanks have been fitted with pumps to force cleaning solution through the air tubes. This was supposed to clean these tanks. I have no information on results obtained by this cleaning method. If complete coverage of the tank interior can be accomplished, this method could be successful.

The rotating head fitted with spray nozzles can be installed in tanks. This device will clean tanks, if it is supplied with the proper chemical solution, under the ideal pressure. This device has limitations. It can't spray around corners or behind shafts. It must be carefully engineered and installed. The nozzles must be adjusted to overlap and completely cover the surface to be cleaned. The problem of being self-draining and sanitary in design must be met. Ordinary pipe threads on the nozzles must be removed and a sanitary connection made. This rotating nozzle equipped head must be carefully installed in a tank to be successful.

The self-rotating cleaning head has the same diffi-

culty in cleaning tanks as do the other devices. Along with these problems are ones inherent in the design of the rotating mechanism. The bearings must be sanitary, self-cleaning and self-draining. Cleaning solutions and the temperature of them affect the operation of this device. Because it is jet operated, pressure affects its speed. This is another device that can clean tanks if all the engineering problems are solved and if it is properly installed in a tank that can be cleaned by mechanical means.

The slotted jet mechanism that is rotated by a separate motor will clean tanks with horizontal agitators or air agitation, if properly installed. The solution comes from the jet near the top of the tank. The jet puts solution on the top surface to be cleaned and into the sight glass and vent openings. The solution flows down the sides of the tank to clean these surfaces. The device requires that a four inch sanitary ferrule be welded into the top of the tank. The mechanism attaches to this ferrule with a four inch sanitary nut. It is self-supporting and the motor is part of the unit. This makes a sanitary, easily inspected device, as the slotted jet comes apart for visual inspection.

The slotted jet device has given perfect cleaning results when installed on a vertical agitator shaft. The tank is cleaned because the slotted jet completely covers the inside of the tank, provided it has been designed to be cleaned by mechanical means.

Care must be exercised that this device is not rotated too fast. At thirty-six R.P.M. the device will clean a tank sixteen feet long. Longer tanks require slower speed agitator motors. Two speed motors have solved this problem.

Some tanks are not made to be cleaned mechanically. It is better to admit this fact and save trouble and misunderstanding when the proper results are not obtained.

From this evaluation of the available mechanical cleaning methods, it is apparent that a good practical method of cleaning storage tanks can be worked out and has been developed to a point where success is assured.

Along with the description of recent cleaning device developments, should go a description of Cleaning Methods as related to chemicals, time, temperature, rinsing, sanitizing and volume of solutions required. Much work has been done along these lines and some practical answers to the questions have been developed.

We have found that a good pre-rinse with tempered water does the best job of removing the loose soil in storage tanks. This temperature range is ninety to one hundred-ten degrees F. Applying three-tenths of a gallon to each square foot of tank surface will result in a good pre-rinse job. This figure is correct when a slotted fan shaped jet was used. A good practical way of deciding on the amount of pre-rinse water to use is to observe the rinse water as it leaves the tank outlet. When it is clear, the tank can be considered to be adequately rinsed.

We recommend that the advice of the Chemical Supplier be followed. These people know their products and what they will do. They have the materials to properly clean these tanks by mechanical means, so they should be consulted in their use. The strength of the solution must be strong enough to remove the soil in the tank. Too much chemical only results in waste. We feel that the solution temperature should be kept as low as possible. However, the chemical in question may require a minimum temperature, so you have to follow its recommendations. Remember that heat causes the stainless steel to expand, cold causes it to contract. These forces should be held in check. Results have proven that cleaning can be accomplished by a maximum solution temperature of one hundred thirty-five degrees F. The slotted jet delivering fifty g.p.m. to the interior surfaces of the tank, will clean a two thousand gallon storage tank in ten minutes.

A cooling fresh water rinse should be applied after the cleaning solution treatment. This removes all traces of the solution and cools the tank surfaces. Good rinsing is essential to good cleaning.

Mechanical cleaning to be successful depends on these things. Complete coverage of the surfaces to be cleaned, with a chemical solution of the proper concentration, heated to and maintained at the proper temperature. The solution must be kept in contact with the tank surfaces for the prescribed length of time. Coverage, time, temperature and solution concentration are the things necessary to insure clean tanks.

An important side effect to consider when cleaning storage tanks, is the cooling system on the individual tank. Hot solutions contacting the refrigerated zone can cause much grief, if the proper precautions are not followed. It is essential that a refrigeration engineer be consulted before proceeding with mechanical cleaning.

From developments up to this time it is apparent that we can clean storage tanks by mechanical means. The system can be automatized to any desired degree. Installing an automatic circulation cleaning system insures that time, temperature and solution concentration are maintained. Installing flow diversion valves in the lines to and from the tanks to be cleaned and applying controls and indicators to them will make a system push button in operation.

In other words, pushing button number one would clean tank number one automatically. All precautions would be observed by the control system. If

the tank wasn't empty, a control would not allow the cleaning operation to begin. Anything desired can be built into the automatic system.

These recent developments have indicated that a practical method of cleaning tanks mechanically has been developed to the point where success is assured.

These developments have proven that steps are being taken to make mechanical cleaning more easily acceptable by the industry. The biggest step is to build storage tanks with mechanical cleaning in mind.

This requires some head scratching by the designers and means that we all have to change our ideas about the inside of the storage tank. It is very difficult to apply a good mechanical cleaning device to a tank built years ago for hand cleaning.

The outlet of the storage tank can generally be cleaned mechanically. The manhole, door and gasket on most tanks have to be washed by hand. This is true when mechanical cleaners are used. The sight glass opening on most tanks has to be removed and hand washed. The product inlet and air vent openings are a hand washing job. The test valve must be hand cleaned. The measuring device on the tank must be hand cleaned. The agitator bearing must be cleaned by hand. From this list of hand cleaned parts and fittings, it is apparent that consideration must be given to redesign. The parts mentioned above should be redesigned to permit mechanical cleaning.

It is possible to build a storage tank now so that these parts could be cleaned mechanically. The problems of how to work around the parts that must be hand cleaned are solved.

Suppose the manhole and the door were moved to the top of the tank. Now the door is only used for inspection and could be much lighter and would be out of the product zone. The air vent would be placed on this door. The product inlet can be in this door, or in many cases, the product can enter the tank through the outlet valve. This method would remove the product inlet and its cleaning problem. A practical method of measuring the volume of liquid in the tank is available. Known as the bubble system, it only requires a small sanitary C.I.P. fitting on the bottom of the tank. The indicating thermometer fitting is no problem. The test cock may have to be cleaned by hand, if it is necessary to have one on the tank. If a sightglass is necessary, it can be of the new flush mounted C.I.P. type that is readily cleanable. The vertical agitator has the cleaning device mounted as an integral part. This agitator is self-cleaning and its support bearing is also self-cleaning.

When tanks are built along these lines, mechanical cleaning will be easy and guaranteed results will be obtained.

The cleaning devices are developed and are practical. Now remains the problem of building storage tanks to take advantage of these labor-saving methods.

NEWS AND EVENTS

HELPFUL INFORMATION

Editor's Note: Listed below are sources of information on a variety of subjects. Requests for any of the material listed should be sent directly to the publisher or the source indicated.

Milk Consumption by Older Persons. Bulletin 339. Storrs Agric. Expt. Sta., Univ. of Conn., Storrs, Connecticut.

Book: *Environmental Sanitation.* J. A. Salvato, Jr. Wiley & Co., 440 Fourth Ave., N. Y. 1958. 660 pp. $12.00.

Book: *The Examination of Waters and Water Supplies.* 7th ed. E. Windle Taylor. Boston, Mass. Little Brown Co., 34 Beacon Street. 1958. 841 pp. $18.50.

Bulletin: *Influence of hard water on dairy detergents.* New Mex. Agr. Exp. Sta. Bul. 427. State College, New Mexico.

Bulletin: Technical Series, No. 1. *Accurate Weights for Can Milk.* No. 2. *Measuring Bulk Milk.* Wisconsin State Department of Agriculture, Madison, Wisconsin.

Bulletin: *Installation Methods for Food Equipment,* Program and Planning Division, Los Angeles City Health Dept.

Bulletin: *Training Program Bulletin,* July 1, 1959 to June 30, 1960 Public Health Service, Communicable Disease Center, Atlanta, Georgia.

Bulletin: *Treatment of Surface Water Supplies for Farm Use* University of Missouri, Agricultural Experiment Station Research Bulletin 589.

Report: *Time–Temperature Effects on Salmonellae and Staphylococci in Foods.* Technical Report F59-2. U. S. Dept. of Health, Education and Welfare, the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

DR. BENDIXEN RECIPIENT OF MASTER TEACHING AWARD

Dr. H. A. Bendixen, professor of dairy science at the State College of Washington, has been chosen by the American Dairy Science Association to receive the Master Teaching Award of the Milk Industry Foundation for 1959. Dr. Bendixen was presented with a $1000 check and a commemorative plaque.

The honor for excellence in teaching, given by the Foundation in alternate years to the outstanding professor of dairy manufacturing and administration, was awarded to Dr. Bendixen at the 54th annual meeting of the ADSA.

Mr. C. V. Christiansen of the Bowman Dairy Company, Chicago, who bestowed the honor upon the college professor, cited him for "his outstanding service to the dairy industry."

A past president of the American Dairy Science Association, Dr. Bendixen has served Washington State College and the dairy industry for 32 years.

The first Master Teaching Award was presented by the Milk Industry Foundation in 1955 to Professor F. E. Herzer of Mississippi State College. In 1957, Dr. G. M. Trout of Michigan State University was selected to receive the honor. Dr. Trout was chairman of the committee who selected the 1959 recipient. The award is sponsored by MIF to recognize educators who have performed outstanding work in teaching dairy manufacturing.

INSTITUTE OF SANITATION MANAGEMENT TO CONVENE IN SEPTEMBER

The Institute of Sanitation Management will hold its annual conference September 22-24 in New York City. Subjects to be covered include modern building sanitation programs, audio visual training in sanitation, facts about fumigation, sanitation in food processing, hospital and institutional sanitation and techniques in providing sanitation consulting service.

A number of prominent I. A. M. F. S. members are on the program including, Keith Fitch of Klenzade Products, J. Lloyd Barron of the National Biscuit Co., A. E. Abrahamson of the New York City Health Department and Harold Wainess of Harold Wainess Associates, Chicago.

STATUS OF IRRADIATION PRESERVATION OF FOODS[1]

Radiation has been conceived as accomplishing several results in connection with preservation. The attainment of these results requires the use of particular amounts of radiation. A knowledge of what is required for each purpose is significant not only in accomplishing the purpose but also in establishing the degree of other changes, for example, flavor changes, resulting from the radiation treatment. Hence, such knowledge is basic to all other considerations.

The most radiation-resistant bacterium of public health significance is *Clostridium botulinum.* While the concept that the radiation dose required to destroy this organism will vary with the food in question has been accepted, the current working figure for complete destruction of this organism is 4.8 million rad.* This is a large amount of radiation.

For pasteurization, the dose requirement varies greatly with the food item and with the desired product life extension. In all probability, most pasteurizing applications will fall within the range of 50,000 to 500,000 rad.

A possible practical use of the method has to do with Trichinae sterilization in pork. The dose required

[1]Report by H. E. Robinson, in Proceedings of the Food and Nutrition Board, National Research Council, Vol. 19, Apr. 1959.

*A rad is 6.24×10^7 million equivalent volts per gram.

to produce sexual sterilization (not death) for this parasite is considered to be about 30,000 rad.

Another possible practical use is sprout inhibition in tuberous vegetables. This dose appears to be of the order of 7,000 rad and is fairly critical since other changes affecting storage stability are produced by larger amounts of radiation.

The most important factor concerned, the block in any commercial use of this process in the meat industry to date, has been product acceptability. Changes induced by radiation vary greatly with the food item in question and with the amount of radiation employed. Of the changes involved in food acceptability from an organoleptic point of view, the following may be listed:

Flavor change uniquely different but resembling scorching; color changes, both darkening and bleaching, and also change of character.

Textural changes, especially noticed with fruits and vegetables; and changes on storage of foods resulting from action of agents not controlled by radiation, including enzyme reactions and chemical reactions.

To give a complete picture would require an individual discussion of each food item. However, it may be noted that, at sterilizing doses, flavor changes are virtually non-existent in certain sea food items such as oysters and shrimp. Likewise, chicken and pork display hardly detectable off flavors. Beef, on the other hand, ordinarily develops a strong off-flavor. Recent work at the University of Michigan indicates that certain combinations, either natural or synthetic, of materials found in tomato will control the development of off-flavor in beef. Dairy products, in general, are very bad. Work at M.I.T. is under way on a process of concurrent radiation and vacuum deodorization. This process shows some promise.

At pasteurizing doses, many products have acceptable flavors, including most meats, sea foods, and certain fruits and vegetables. In particular instances, there may be other changes induced by the radiation which will affect the acceptability of the product. This is especially true in meats where chemical changes lead to appearance degradation in a short time. It would appear that there may be some useful applications of pasteurization in the treatment of certain fruits and vegetables such as citrus fruits.

The level of radiation required to control trichinae in pork does not affect its acceptability. Likewise, the level of radiation proposed for control of sprouting has no effect on acceptability of potatoes and onions.

In all foods which contain naturally occurring enzymes, radiation at the sterilizing level and below does not inactivate such enzymes. The amount of radiation which will inactivate these enzymes appears to be of the order of several times that required for sterilization. Hence, it is present thinking that some other process for inactivating enzymes will be needed. At this time, the most effective method seems to be heat inactivation. Thus, one may conclude that foods which contain enzymes will first be heat-treated and consequently will have some cooked characteristics. Failure to inactivate the enzyme leads to flavor changes, texture changes and, in certain instances, the growth of tyrosine crystals through hydrolysis of the protein, for example, in meats.

Product acceptability has been evaluated largely by scientifically trained people. There has been some exposure to consumer-type groups in academic circles and in certain military establishments. Perhaps a fair summary of the results to date would be as follows:

Even with strong irradiated flavors, an inexpert group on first exposure will not detect them. Practically all testing with inexpert groups has involved single exposures; hence, there is no current knowledge as to what will happen on replication. Work with expert panels indicates that ability to detect irradiated flavor can be improved through practice, and once a sensitivity to it has been developed, the flavor becomes objectionable.

What is needed are additional consumer studies involving replications. It is probable that the Army Quartermaster will conduct such studies in the near future.

A great deal of effort has been expended both with private funds and with Army money on investigating the wholesomeness of irradiated foods. Much of this work has been planned by highly competent groups, including the Federal Food and Drug Administration, the Army Surgeon General, and various academic and industrial organizations. The findings to date have been almost exclusively favorable. Studies involving short-and long-term animal feedings, enzyme system studies, carcinogenic activity, and limited human feeding have pointed to no real difficulty attributable to changes caused by irradiation. One investigator has observed a hemorrhagic syndrome in rats fed beef. Current thinking is that this observation has no significance to the wholesomeness of irradiated beef.

Currently, there is considerable concern in the area of induced radioactivity in irradiated foods. When certain forms of ionizing radiation are employed, certain atoms present in the food become radioactive. These effects occur principally with the use of high voltage electron beams, although they will result from the employment of gamma ray sources, which include some neutron flux. The level of radio-

activity induced is low but measurable. One might hold the view that the level is so low as to have no significance when one considers other sources of radioactive atoms normal to the human diet, or when one considers exposures to ionizing radiation normally encountered from various sources such as therapeutic and diagnostic X-rays and cosmic rays. However, this subject is under very active consideration by the Army Surgeon General, the Army Quartermaster, and the Federal Food and Drug Administration. One can understand the viewpoint that holds objection to any added ionizing radiation exposure. To indicate how seriously this matter is being considered, the Army recently prohibited the consumption of any irradiated food by any Army personnel.

The significant forms of radiation for preservation are electron beams and gamma rays. There have been available for a number of years various sources of electron beams, the most significant of which are the Van de Graaff, the resonant transformer, and the linear accelerator. The first two sources appear to be the least expensive; however, they cannot produce electron beams beyond 5,000,000 volts. The linear accelerator theoretically has no top limit, and the Army Ionizing Radiation Center at Lathrop, California, is to be equipped with a 24 million volt linear accelerator. This will provide a penetration of about six inches of unit density materials.

Gamma ray sources are principally of two kinds: (1) the fission products from uranium or plutonium reactors; or (2) artificially made radioactive materials such as cobalt 60. The gamma rays usually have a penetration of a foot or more. The fission products can be used as purified materials, such as Cesium 137 or "hot" fuel rods taken directly out of a reactor. It is probable that the Army Ionizing Radiation Center will be equipped with a cobalt 60 gamma ray source.

While there is considerable difference of opinion on this point, it would appear that the electron beam sources are more economical than the gamma sources at this time.

One might analyze the work to date, as far as food items are concerned, as largely directed to proving wholesomeness and finding out which items are acceptable organoleptically. There has been some basic research to find ways to control the flavor changes resulting from radiation. So far, this has not been very fruitful. The notable exception seems to be the work at the University of Michigan where, apparently, materials have been found which block the chemical reactions involved in the flavor change. It is clear that much more basic research needs to be done in order to establish radiation preservation as a workable food process.

MILK CARTON WAXES HELD NO HAZARD

By World Wide Medical News Service
Washington Bureau

No indications of a health hazard have been found in studies of possible cancer-producing agents in wax used for milk cartons and other food containers, Arthur S. Flemming, Secretary of Health, Education, and Welfare, said here. However, he added, the Food and Drug Administration plans further studies of the waxes.

Studies of the waxes began in 1956. Twenty-four waxes were analyzed by Drs. Philippe Shubik and William Lijinsky, Division of Chemistry, Chicago Medical School, who reported in 1957 that one wax contained a known carcinogen, 1,2,5,6-dibenzanthracene. While this compound produced cancer in laboratory animals, it has not been shown to produce cancer in man, Flemming said.

In 1958, samples of the 24 waxes sent to Dr. Shubik were also sent to Dr. Paul Kotin, Associate Professor of Pathology, University of Southern California. Flemming said that the Kotin research confirmed the Shubik findings that one wax contained between 0.5 and 1.0 microgram of 1,2,5,6,-dibenzanthracene and that the compound, when added to dairy waxes for experimental purposes, was extracted from thin layers of wax by milk.

"I am advised that the findings are not final but no indications of a health hazard have been found," Flemming said. "The Food and Drug Administration advises there is at present no basis for action concerning these waxes under the Food, Drug and Cosmetic Act . . .

"The Food and Drug Administration plans a study of these waxes in its own laboratories if its appropriation for 1960 as now approved by both House and Senate is finally enacted. The Public Health Service also plans to support further studies . . ."

Reprinted from Scope Weekly, Vol. 4, No. 29, July 15, 1959

COPPER ADSORBED ON STAINLESS STEEL EQUIPMENT MAY CAUSE OXIDIZED FLAVOR

Copper contamination of milk can be a serious cause of oxidized flavor. To reduce such contamination, stainless steel has largely replaced tinned copper and white metals in dairy equipment. Some processors have modernized their equipment to the point that milk comes into contact only with stainless steel or glass – yet milk still picks up copper.

This research has shown that copper can be adsorbed on stainless steel and it might originate from white metal, brass or tinned copper equipment that is washed with or included in the same circulation

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4. In the Vendor, dispenser cans are kept in a refrigerated compartment at constant 33-35°F. Vendor will not operate in case refrigerated compartment rises above 50°F. Switch-over from empty to full dispenser cans is fully automatic.

5. Paper cups are stored in unbroken stacks in an enclosed compartment. They are filled in an enclosed cup station with a self-closing door.

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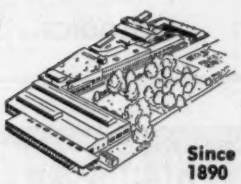

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cleaning unit with the stainless steel milk-contact surfaces. Furthermore, it has been shown that this adsorbed copper may cause milk to have an oxidized flavor. Particularly will this be true in the first milk passing through the equipment after cleaning and sanitizing treatments. The obvious solution is to eliminate all copper-nickel alloys from dairy equipment.

Where copper-nickel alloys are used, approaches are indicated for minimizing contamination from adsorbed copper. The detergent selected for cleaning should cause as little corrosion of white metal as possible, thereby preventing copper from becoming available for adsorption on stainless steel. Conditions provided during circulation cleaning, particularly the final stages should be selected to minimize adsorption of copper on stainless steel. In the experiments described, copper adsorption was slight or absent at low or very high pH, in the presence of a chelating agent, or with very low copper concentration. Hypochlorite sanitizer increased copper adsorption. If the conditions used for part of the cleaning process permit copper adsorption, a treatment that removes adsorbed copper, such as by a noncorrosive acid or a chelating agent, may be included near the end of the sanitizing procedure. If copper contamination from adsorbed copper is excessive, some of the first milk processed in equipment may be discarded to reduce contamination of the entire supply.

W. L. Dunkley and R. L. King: Adsorption of Copper on Stainless Steel. Journal of Dairy Science, March, 1959.

KENTUCKY DAIRY CONFERENCE TO BE HELD IN NOVEMBER

The 1959 annual Dairy Manufacturing Conference at the University of Kentucky will be held November 17-19.

This conference is sponsored jointly by the Dairy Section of the University of Kentucky and the Dairy Products Association of Kentucky.

Nationally recognized authorities on dairy problems will be on the conference staff to discuss industry problems from the source of raw materials to the disposal of waste.

Tuesday, November 17th will be devoted to prob-

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lems of ice cream, concluding with an ice cream clinic to help Kentucky manufacturers compare their product with those of their competitors.

Market milk will be featured on Wednesday, November 18th and will include discussions on cultured products as well. A cultured product clinic will be featured and a milk scoring contest will be held. The annual banquet held in conjunction with the Tri-City Dairy Technology Society will also be held on that day.

The rapidly growing Kentucky cheese industry will have its day on November 19th.

For further information concerning the conference, Dr. A. W. Rudnick, Dairy Section, University of Kentucky, Lexington, Kentucky, should be contacted.

COLORED DYE FINDS ANTIBIOTICS IN COWS' MILK[1]

Antibiotics used for mastitis therapy are secreted in milk and make it unsuitable for the manufacture of cultured dairy products. Also, there is a possibility that antibiotics consumed through milk might produce ill effects in human beings.

Dr. Khem Shahani of the Nebraska Agricultural Experiment Station described a method involving the mixing of a green-turquoise dye with an antibiotic preparation and introducing it through the teat canal. The dye, along with the antibiotic, appears in milk, coloring it green. The color intensity of the dye in the milk is in direct relation to the antibiotic concentration. The dye appears in the milk for approximately the same length of time as the antibiotic.

Through this method, antibiotics can be detected visually without need for the present time-consuming bacteriological tests.

This method seems to work well with penicillin, aureomycin, terramycin or polymixin – the antibiotics often used for mastitis therapy, Dr. Shahani stated.

Age and breed do not seem to affect the number of milkings for which the dye appeared in milk, he added. During storage of antibiotic-dye mixtures for several months, the dye exerted no appreciable effect on the stability of the antibiotics.

The dye does not seem to cause any apparent irritation to the udder tissue, adverse effect on the milk yield or health of the animal or toxic effects when consumed by humans, he concluded.

[1]*Abstract of paper given at 54th annual meeting of Amer. Dairy Science Assoc., June, 1959.*

PLASTIC PIPE LINES FOUND SATISFACTORY[1]

Plastic hose has worked as well as stainless steel for pipeline milking systems in experiments at the University of Illinois, say Professor M. H. Alexander and Professor E. E. Ormiston of that institution.

Routine procedure for cleaning and sanitizing both the plastic hose and the stainless steel pipeline is as follows:

1. Rinse thoroughly for five minutes with clean water at a temperature of about 90° to 100° F. immediately after milking.
2. Wash with a hot synthetic alkaline detergent solution for about 20 minutes for three milkings. On the fourth milking, use an acid rather than an alkaline detergent. Both types of detergents are adapted to the hardness of the water.
3. Sanitize by rinsing for five minutes with 200 parts per million of chlorine solution at 90°to 100° F.
4. Rinse with a similar chlorine solution just before next milking.

Alexander and Ormiston reported that the results of this study clearly showed that milk of satisfactory quality could be obtained when transported from cows to the milk house through a plastic hose that had been cleaned as outlined above. They cannot predict how long the plastic hose will last in such an operation. They do know that it will be softened considerably if water of 170° temperature or higher is used for cleaning. However, when water at 140° to 145° is used, the hose stays firm.

[1]*Abstract of paper given at 54th annual meeting of Amer. Dairy Science Assoc., June, 1959.*

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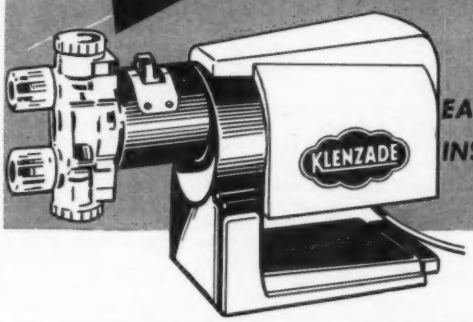

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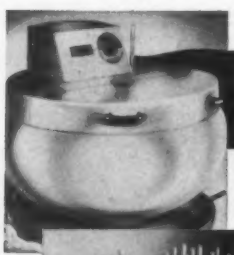

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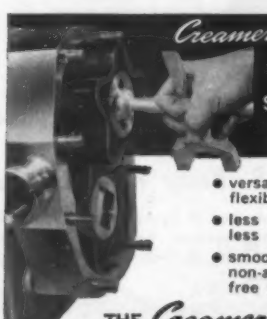

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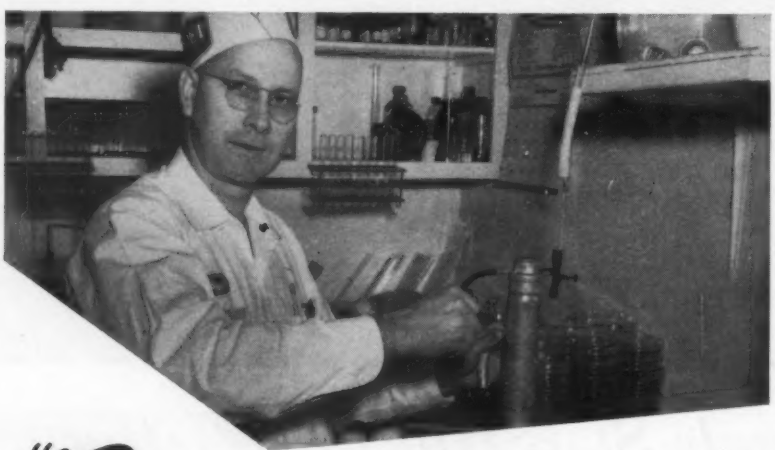

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